5.0 RESULTS

This report describes how artificial propagation was factored into first determining ESU membership and second, in assessing ESU viability. For further explanation of artificial propagation in the context of ESA listing decisions, readers are directed to the proposed Hatchery Listing Policy.

5.1 CONSIDERING ARTIFICIAL PROPAGATION IN DEFINING ESUS

Hatchery-origin fish determined genetically to be no more than moderately divergent from a natural population included in the ESU are considered part of the ESU (NMFS 2004d). To assist NOAA Fisheries in determining ESU membership, a Salmon and Steelhead Hatchery Assessment Group (SSHAG), composed of NOAA Fisheries scientists from the Northwest and Southwest Fisheries Science Centers, evaluated the best available information describing the relationships between hatchery-origin fish and natural-origin salmon and anadromous *O. mykiss* in the Pacific Northwest and California. The SSHAG produced a report, "Hatchery Broodstock Summaries and Assessments for Chum, Coho, and Chinook Salmon and Steelhead Stocks within Evolutionarily Significant Units Listed under the Endangered Species Act" (NMFS 2003a), which described the relatedness of hatchery-origin fish on the basis of broodstock origin and the degree of known or inferred genetic divergence between hatchery-origin fish and the local natural population(s). NOAA Fisheries utilized the information presented in the SSHAG Report to determine the ESU membership of those hatchery-origin fish determined to be within the historical geographic range of a given ESU. NOAA Fisheries' assessment of individual hatchery programs and its findings regarding the ESU membership are detailed in (NMFS 2004a). Hatchery programs included in a given ESU are listed below in Table 5.1.

Table 5.1. List of artificial propagation programs included in Evolutionarily Significant Units (ESUs) of West Coast salmon and *Oncorhynchus mykiss*.

Evolutionarily Significant Unit (ESU)	Artificial Propagation Program	Run	Location (State)
Snake River sockeye ESU	Redfish Lake Captive Propagation Program	n/a	Stanley Basin (Idaho)
Ozette Lake sockeye ESU	Umbrella Creek Hatchery – Makah Tribe	n/a	Ozette Lake (Washington)
	Big River Hatchery – Makah Tribe	n/a	Ozette Lake (Washington)
Sacramento River winter-run chinook ESU	Livingston Stone National Fish Hatchery (NFH) Conservation Program Captive Broodstock Program	 Winter Winter	 Sacramento River (California) Livingston Stone NFH & Univ. of Calif. Bodega Marine Laboratory (California)
Central Valley spring-run chinook ESU	n/a		
California Coastal chinook ESU	Freshwater Creek/Humboldt Fish Action Council	Fall	Freshwater Creek, Humboldt Bay (California)
	Yager Creek Hatchery	Fall	Yager Creek, Van Duzen River (California)
	Redwood Creek Hatchery	Fall	Redwood Creek, South Fork Eel River (California)
	Hollow Tree Creek Hatchery	Fall	Eel River (California)
	Mattole Salmon Group Hatchery	Fall	Squaw Creek, Mattole River (California)
	Van Arsdale Fish Station	Fall	Eel River (California)
	Mad River Hatchery	Fall	Mad River (California)
Upper Willamette River chinook ESU	McKenzie River Hatchery (Oregon Department of Fish & Wildlife (ODFW) stock #24)	Spring	McKenzie River (Oregon)
	Marion Forks Hatchery (ODFW stock #21)	Spring	North Fork Santiam River (Oregon)
	South Santiam Hatchery (ODFW stock #23)	Spring	South Fork Santiam River (Oregon)
		Spring	Calapooia River (Oregon)
		Spring	Mollala River (Oregon)
	Willamette Hatchery (ODFW stock #22)	Spring	Middle Fork Willamette River (Oregon)
	Clackamas Hatchery (ODFW stock # 19)	Spring	Clackamas River (Oregon)
Lower Columbia River chinook ESU	Sea Resources Tule chinook Program	Fall	Chinook River (Washington)
	Big Creek Tule chinook Program	Fall	Big Creek (Oregon)
	Astoria High School (STEP) Tule chinook Program	Fall	Big Creek (Oregon)
	Warrenton High School (STEP) Tule chinook Program	Fall	Big Creek (Oregon)
	Elochoman River Tule chinook Program	Fall	Elochoman River (Washington)
	Cowlitz Tule chinook Program	Fall	Lower Cowlitz River (Washington)
	North Fork Toutle Tule chinook Program	Fall	Cowlitz River (Washington)
	Kalama Tule chinook Program	Fall	Kalama River (Washington)
	Washougal River Tule chinook Program	Fall	Washougal River (Washington)
	Spring Creek NFH Tule Chinook Program	Fall	Upper Columbia River Gorge (Washington)

Evolutionarily Significant Unit (ESU)	Artificial Propagation Program	Run	Location (State)
Lower Columbia River chinook ESU (continued)	Cowlitz spring chinook Program	Spring	Upper Cowlitz River (Washington)
		Spring	Cispus River (Washington)
	Friends of Cowlitz spring chinook Program	Spring	Upper Cowlitz River (Washington)
	Kalama River spring chinook Program	Spring	Kalama River (Washington)
	Lewis River spring chinook Program	Spring	Lewis River (Washington)
	Fish First spring chinook Program	Spring	Lewis River (Washington)
	Sandy River Hatchery (ODFW stock #11)	Spring	Sandy River (Oregon)
Upper Columbia River spring chinook ESU	Twisp River	Spring	Methow River (Washington)
	Chewuch River	Spring	Methow River (Washington)
	Methow Composite	Spring	Methow River (Washington)
	Winthrop NFH (Methow Composite stock)	Spring	Methow River (Washington)
	Chiwawa River	Spring	Wenatchee River (Washington)
	White River	Spring	Wenatchee River (Washington)
Puget Sound chinook ESU	Kendall Creek Hatchery	Spring	North Fork Nooksack River (Washington)
	Marblemount Hatchery	Fall	Lower Skagit River (Washington)
		Spring (yearlings)	Upper Skagit River (Washington)
		Spring (sub-yearlings)	Upper Skagit River (Washington)
		Summer	Upper Skagit River (Washington)
	Harvey Creek Hatchery	Summer	North Fork Stillaguamish River (Washington)
	Whitehorse Springs Pond	Summer	North Fork Stillaguamish River (Washington)
	Wallace River Hatchery	Summer (yearlings)	Skykomish River (Washington)
		Summer (sub-yearlings)	Skykomish River (Washington)
	Tulalip Bay (Bernie Kai-Kai Gobin Hatchery/Tulalip Hatchery)	Summer	Skykomish River/Tulalip Bay (Washington)
	Soos Creek Hatchery	Fall	Green River (Washington)
	Icy Creek Hatchery	Fall	Green River (Washington)
	Keta Creek – Muckelshoot Tribe	Fall	Green River (Washington)
	White River Hatchery	Spring	White River (Washington)
	White Acclimation Pond	Spring	White River (Washington)
	Hupp Springs Hatchery	Spring	White River (Washington)
	Voights Creek Hatchery	Fall	Puyallup River (Washington)
	Diru Creek	Fall	Puyallup River (Washington)

Evolutionarily Significant Unit (ESU)	Artificial Propagation Program	Run	Location (State)
Puget Sound chinook ESU (continued)	Clear Creek	Fall	Nisqually River (Washington)
	Kalama Creek	Fall	Nisqually River (Washington)
	Dungeness/Hurd Creek Hatchery.	Spring	Dungeness River (Washington)
	Elwha Channel Hatchery	Fall	Elwha River (Washington)
Snake River fall-run chinook ESU	Lyons Ferry Hatchery	Fall	Snake River (Idaho)
	Fall Chinook Acclimation Ponds Program – Pittsburg, Captain John, and Big Canyon ponds	Fall	Snake River (Idaho)
	Nez Perce Tribal Hatchery – including North Lapwai Valley, Lakes Gulch, and Cedar Flat Satellite facilities	Fall	Snake and Clearwater Rivers (Idaho)
	Oxbow Hatchery	Fall	Snake River (Oregon, Idaho)
Snake River spring/summer-run chinook ESU	Tucannon River Hatchery (conventional)	Spring	Tucannon River (Idaho)
	Tucannon River Captive Broodstock Program	Spring	Tucannon River (Idaho)
	Lostine River (captive/conventional)	Summer	Grande Ronde (Oregon)
	Catherine Creek (captive/conventional)	Summer	Grande Ronde (Oregon)
	Lookingglass Hatchery (reintroduction)	Summer	Grande Ronde (Oregon)
	Upper Grande Ronde (captive/conventional)	Summer	Grande Ronde (Oregon)
	Imnaha River	Spring/ Summer	Imnaha River (Oregon)
	Big Sheep Creek	Spring/ Summer	Imnaha River (Oregon)
	McCall Hatchery	Spring	South Fork Salmon River (Idaho)
	Johnson Creek Artificial Propagation Enhancement	Spring	East Fork South Fork Salmon River (Idaho)
	Lemhi River Captive Rearing Experiment	Spring	Lemhi River (Idaho)
	Pahsimeroi Hatchery	Summer	Salmon River (Idaho)
	East Fork Captive Rearing Experiment	Spring	East Fork Salmon River (Idaho)
	West Fork Yankee Fork Captive Rearing Experiment	Spring	Salmon River (Idaho)
	Sawtooth Hatchery	Spring	Upper Mainstem Salmon River (Idaho)
Central California Coast coho ESU	Don Clausen Fish Hatchery Captive Broodstock Program	n/a	Dry Creek, Russian River (California)
	Scott Creek/Kingfisher Flat Hatchery Conservation Program (Monterey Bay Salmon and Trout Project)	n/a	Big Creek, Scott Creek (California)
	Scott Creek Captive Broodstock Program	n/a	NOAA Southwest Fisheries Science Center, Santa Cruz (California)
	Noyo River Fish Station egg-take program	n/a	Noyo River (California)

Evolutionarily Significant Unit (ESU)	Artificial Propagation Program	Run	Location (State)
Southern Oregon/Northern California Coast coho ESU	Cole Rivers Hatchery (ODFW stock #52)	n/a	Rogue River (Oregon)
	Trinity River Hatchery	n/a	Trinity River (California)
	Iron Gate Hatchery	n/a	Klamath River (California)
Oregon Coast coho ESU	North Umpqua River (ODFW stock #55)	n/a	Umpqua River (Oregon)
	Cow Creek (ODFW stock #18)	n/a	Umpqua River (Oregon)
	Coos Basin (ODFW stock #37)	n/a	Coos Basin (Oregon)
	Coquille River/Bandon Hatchery (ODFW 44)	n/a	Coquille River (Oregon)
	North Fork Nehalem River (ODFW stock #32)	n/a	Nehalem River (Oregon)
Lower Columbia River coho ESU	Grays River	Type-S	Grays River (Washington)
	Sea Resources Hatchery	Type-S	Grays River (Washington)
	Peterson Coho Project	Type-S	Grays River (Washington)
	Big Creek Hatchery (ODFW stock # 13)	n/a	Big Creek (Oregon)
	Astoria High School (STEP) Coho Program	n/a	Youngs Bay (Oregon)
	Warrenton High School (STEP) Coho Program	n/a	Youngs Bay (Oregon)
	Elochoman Type-S Coho Program	Type-S	Elochoman River (Washington)
	Elochoman Type-N Coho Program	Type-N	Elochoman River (Washington)
	Cathlamet High School FFA Type-N Coho Program	Type-N	Elochoman River (Washington)
	Cowlitz Type-N Coho Program	Type-N	Upper Cowlitz River (Washington)
	Cowlitz Type-N Coho Program	Type-N	Lower Cowlitz River (Washington)
	Cowlitz Game and Anglers Coho Program	n/a	Lower Cowlitz River (Washington)
	Friends of the Cowlitz Coho Program	n/a	Lower Cowlitz River (Washington)
	North Fork Toutle River Hatchery	Type-S	Cowlitz River (Washington)
	Lewis River Type-N Coho Program	Type-N	North Fork Lewis River (Washington)
	Lewis River Type-S Coho Program	Type-S	North Fork Lewis River (Washington)
	Fish First Wild Coho Program	n/a	North Fork Lewis River (Washington)
	Fish First Type-N Coho Program	Type-N	North Fork Lewis River (Washington)
	Syverson Project Type-N Coho Program	Type-N	Salmon River (Washington)
	Sandy Hatchery (ODFW stock # 11)	Late	Sandy River (Oregon)
	Bonneville/Cascade/Oxbow Complex (ODFW stock # 14)	n/a	Lower Columbia River Gorge (Oregon)
Columbia River chum ESU	Chinook River/Sea Resources Hatchery	Fall	Chinook River (Washington)
	Grays River	Fall	Grays River (Washington)
	Washougal Hatchery/Duncan Creek	Fall	Washougal River (Washington)
Hood Canal summer-run chum ESU	Quilcene/ Quilcene NFH	Summer	Big Quilcene River (Washington)
	Hamma Hamma Fish Hatchery	Summer	Western Hood Canal (Washington)
	Lilliwaup Creek Fish Hatchery	Summer	Southwestern Hood Canal (Washington)
	Union River/Tahuya	Summer	Union River (Washington)

Evolutionarily Significant Unit (ESU)	Artificial Propagation Program	Run	Location (State)
Hood Canal summer-run chum ESU (continued)	Big Beef Creek Fish Hatchery	Summer	North Hood Canal (Washington)
	Salmon Creek Fish Hatchery	Summer	Discovery Bay (Washington)
	Chimacum Creek Fish Hatchery	Summer	Port Townsend Bay (Washington)
	Jimmycomelately Creek Fish Hatchery	Summer	Sequim Bay (Washington)
Southern California *O. mykiss* ESU	n/a		
South-Central California Coast *O. mykiss* ESU	n/a		
Central California Coast *O. mykiss* ESU	Scott Creek/Monterey Bay Salmon and Trout Project, Kingfisher Flat Hatchery	Winter	Big Creek, Scott Creek (California)
	Don Clausen Fish Hatchery	Winter	Russian River (California)
California Central Valley *O. mykiss* ESU	Coleman NFH	Winter	Battle Creek, Sacramento River (California)
	Feather River Hatchery	Winter	Feather River (California)
Northern California *O. mykiss* ESU	Yager Creek Hatchery	Winter	Yager Creek, Van Duzen River (California)
	North Fork Gualala River Hatchery/Gualala River Steelhead Project	Winter	North Fork Gualala River (California)
Upper Willamette River *O. mykiss* ESU	n/a		
Lower Columbia River *O. mykiss* ESU	Cowlitz Trout Hatchery	Late Winter	Cispus River (Washington)
	Cowlitz Trout Hatchery	Late Winter	Upper Cowlitz River (Washington)
	Cowlitz Trout Hatchery	Late Winter	Tilton River (Washington)
	Cowlitz Trout Hatchery	Late Winter	Lower Cowlitz River (Washington)
	Kalama River Wild	Winter	Kalama River (Washington)
		Summer	Kalama River (Washington)
	Clackamas Hatchery (ODFW stock # 122)	Late Winter	Clackamas River (Oregon)
	Sandy Hatchery (ODFS stock # 11)	Late Winter	Sandy River (Oregon)
	Hood River (ODFW stock # 50)	Winter	Hood River (Oregon)
		Summer	Hood River (Oregon)
Middle Columbia River *O. mykiss* ESU.	Touchet River Endemic	Summer	Touchet River (Washington)
	Yakima River Kelt Reconditioning Program	Summer	Satus Creek (Washington)
		Summer	Toppenish Creek (Washington)
		Summer	Naches River (Washington)
		Summer	Upper Yakima River (Washington)
	Umatilla River (ODFW stock # 91)	Summer	Umatilla River (Oregon)
	Deschutes River (ODFW stock # 66)	Summer	Deschutes River (Oregon)
Upper Columbia River *O. mykiss* ESU	Wenatchee River Steelhead	Summer	Wenatchee River (Washington)
	Wells Hatchery Steelhead	Summer	Methow River (Washington)
		Summer	Okanogan River (Washington)
	Winthrop NFH Steelhead (Wells Steelhead)	Summer	Methow River (Washington)

Evolutionarily Significant Unit (ESU)	Artificial Propagation Program	Run	Location (State)
Upper Columbia River *O. mykiss* ESU (continued)	Omak Creek Steelhead	Summer	Okanogan River (Washington)
	Ringold Hatchery (Wells Steelhead)	Summer	Middle Columbia River (Washington)
Snake River Basin *O. mykiss* ESU	Tucannon River	Summer	Tucannon River (Washington)
	Dworshak NFH	Summer	South Fork Clearwater River (Idaho)
	Lolo Creek	Summer	Salmon River (Idaho)
	North Fork Clearwater	Summer	North Fork Clearwater River (Idaho)
	East Fork Salmon River	Summer	East Fork Salmon River (Idaho)
	Little Sheep Creek/Imnaha River Hatchery (ODFW stock # 29)	Summer	Imnaha River (Oregon)

5.2 CONSIDERATION OF ARTIFICIAL PROPAGATION IN ASSESSING THE BIOLOGICAL STATUS OF ESUS

Biological status was assessed first at the population and then at the ESU level. The viability of individual populations or an ESU in-total depends upon the abundance, productivity, spatial structure, and diversity of the individual populations included in an ESU (McElhany *et al*. 2000, Ruckelshaus *et al*. 2002). The criteria for "Viable Salmonid Populations" (VSP; McElhany *et al*. 2000) are used to guide NOAA Fisheries' risk assessments. The VSP criteria were developed to provide a consistent and logical reference for making risk determinations and are based upon a review and synthesis of the conservation biology and salmon literature. The four VSP criteria are universal indicators of species' viability, and they individually and collectively function as reasonable predictors of extinction risk.

Factors considered in relating population-level VSP criteria to ESU-level risk are described in section 5.2.2.

5.2.1 Consideration of Natural Populations in Assessing ESU Biological Status

NOAA Fisheries' Pacific Salmonid Biological Review Team (BRT) (an expert panel of scientists from several federal agencies including NOAA Fisheries, FWS, and the U.S. Geological Survey) reviewed the viability and extinction risk of naturally spawning populations in the 27 ESUs that are the subject of current status review (NMFS 2003b). The BRT evaluated the risk of extinction based on the performance of the naturally spawning populations in each of the ESUs under the assumption that present conditions will continue into the future. The BRT did not explicitly consider current artificial propagation efforts in its evaluations. However, the benefits and risks associated with past artificial propagation efforts as they are manifested in the present viability of natural populations in an ESU were considered in the BRT's viability assessments.

5.2.2 Consideration of the Entire ESU in Assessing Viability

The proposed Hatchery Listing Policy (NMFS 2004d) provides that status determinations for Pacific salmonid ESUs will be based on the likelihood of extinction of an entire ESU (including both hatchery-origin and natural-origin components). For those ESUs with associated hatchery programs, the BRT's findings represent a partial assessment of the ESU's extinction risk. To determine the biological status of an entire ESU, this report includes hatchery-origin fish in the assessment.

Evaluating Inherent Uncertainties – Artificial propagation efforts represent a level of human intervention with a unique suite of benefits, risks, and uncertainties. Whether and how artificial propagation affects an ESU's biological status and risk of extinction depends upon the ability of the propagation program(s) to effectively contribute to the collective viability of populations within the ESU, as well as whether the program(s) will likely continue operations far enough into the future that potential benefits may be realized. Factors considered in evaluating the potential

effectiveness of propagation programs include but are not limited to: (1) the primary objective of the program (e.g., conservation of genetic resources, reintroduction, supplementation, providing harvest opportunities); (2) the size or scale of the program relative to the carrying capacity of the ecosystem; (3) the source and proportion of natural-origin fish used for broodstock; (4) the number of natural-origin fish collected for broodstock relative to the number allowed to spawn naturally; (5) the extent to which the fish collected for broodstock are representative of the traits of local natural-origin fish (e.g., run timing, size at maturity, habitat use); (6) the program's mating protocols and genetic management plan; (7) the rearing conditions relative to the natural environment; (8) the proportion of hatchery-origin fish that are marked; (9) the rearing and release strategies relative to the natural life history; (10) the proportion of hatchery-origin fish on spawning grounds; (11) the program's disease and handling protocols; (12) the monitoring, evaluation, and adjustment procedures of the program; and (13) safeguards against facility malfunctions and operator errors. Factors considered in evaluating the prospects of artificial propagation programs continuing operations into the future include but are not limited to: (1) the availability of funding and staff resources; (2) program authorization (e.g., approval of hatchery genetic management plans under limit 5 of the ESA 4(d) rule for threatened ESUs, a current section 10(a)(1)(A) enhancement permit); and (3) if a program is part of a larger conservation plan, the level of participation and coordination in, and the timetable for, the plan.